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Does the Mountain Pine Beetle Select and Kill Dwarf Mistletoe-Infected Lodgepole Pine?

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INTRODUCTION

The relative physiological condition of individual lodgepole pines, Pinus contorta Dougl., selected and killed by the mountain pine beetle, Dendroctonus ponderosae Hopkins, has been a topic of debate for many years. Craighead and others (1931) noted that destructive epidemics often developed in trees weakened by a number of causes, but that the larger, thick-barked trees were first attacked during epidemics. Evenden and others (1943) stated that overmature or weakened trees were preferred under endemic conditions, but both young and mature timber stands were subject to attack during severe outbreaks. Hopping and Mathers (1945) indicated that outbreaks were to be expected whenever tree vigor was seriously reduced. Hopping and Beall (1948) obtained a strong correlation between the percentage of trees attacked and diameter, with the largest trees supporting the greatest loss, but they noted that diameter may be correlated with the degree of attractiveness when an entire stand is reduced in vigor. In opposition to these views, Atkins (1966) stated that the mountain pine beetle preferred healthy trees of a particular age class and the irregularity of their habitat was related to plant succession. Roe and Amman (1970) indicated that the beetle first infests the larger diameter trees which usually have thick phloem and are a better food source. Finally, Cole (1973) stated that the postulate that the mountain pine beetle selects weakened or decadent trees is upset by the fact that the largest trees with the thickest phloem are selected.

PREVALENCE OF DISEASED AND WEAKENED TREES

Climate and biological entities often affect the physiological condition of lodgepole pine trees over large areas. One of the more prevalent factors causing widespread reduction in vigor is dwarf mistletoe, Arceuthobium americanum Nutt. ex Engelm. Gill and Hawksworth (1964) estimated that one-third to one-half of the commercial lodgepole pine type in the Intermountain States was affected to some degree by this parasitic plant. The percentage of occurrence may even be higher if noncommercial stands were included in an estimate.

OBJECTIVE

Since epidemic infestations of the mountain pine beetle and dwarf mistletoe occur simultaneously through much of the lodgepole pine

type in the Intermountain Region, the possibility exists that trees infected by mistletoe are selected and killed by the mountain pine beetle (Figure 1, Appendix). Accordingly, surveys were conducted to test this hypothesis. The purpose of this report is to document the results of these surveys.

METHODS

Data were collected in three separate stands on the Targhee National Forest in 1973. A 120 acre tract in the Middle Fork of Split Creek and two 60 acre tracts near Black Mountain and Hatchery Butte were sampled. The mean elevations for Split Creek, Black Mountain, and Hatchery Butte tracts were 7,800, 7,000, and 6,200 feet respectively. Sample plots were systematically located within each survey tract.

Green stand structure and species composition data were collected on 28 variable radius plots (20 BAF) in the Split Creek tract and on 14 variable radius plots (20 BAF) on the Black Mountain and Hatchery Butte tracts. To show the original stand conditions before the recent beetle epidemic, data on all live and dead trees five inches d.b.h. and greater were recorded on variable plots.

Trees killed by the mountain pine beetle were recorded on 24 strip plots in the Split Creek tract and on 12 strip plots in the Black Mountain and Hatchery Butte tracts. One-quarter acre strip plots (5 by 0.5 chains) were used exclusively. Trees killed by engraver beetles, Ips spp., were not sampled.

All trees sampled on green stand and mortality plots were rated by the degree of mistletoe infection, using the six-class rating system developed by Hawksworth and Lusher (1956). In using this system, the crown was divided into thirds and each third was rated as follows:

0 - no mistletoe or indicators

1 - less than half of the branches infected

2 - more than half of the branches infected

The ratings were added to obtain the dwarf mistletoe class rating for a tree.

The average mistletoe rating for each survey tract is the sum of the products of the number of trees per acre and its rating classification, divided by the total number of trees per acre. For example, the rating for Table 1 was determined as follows:

$$\frac{(31.51)(1)+(64.22)(2)+\ldots+(47.71)(6)}{334.17} = 2.95$$

RESULTS

There were considerable differences in the stand structure, species composition, and intensity of mistletoe infection between the three sample tracts. In the Split Creek tract, prior to the outbreak, there were 334 lodgepole pine (Table 1, Appendix), 14 subalpine fir and 18 whitebark pine per acre. Eighty-five percent of the lodgepole pine was infected by mistletoe, 42 percent of which was classified as heavily infected (4, 5, or 6 rating). The average mistletoe rating for the survey tract was 2.95. The Black Mountain survey tract had 313 lodgepole pine and 23 Douglas-fir per acre (Table 2, Appendix). Eighty percent of the lodgepole pine had some degree of mistletoe infection, 46 percent was heavily infected, and the average mistletoe rating was 3.07. In the Hatchery Butte tract, there were 204 lodgepole pine per acre (Table 3, Appendix). Scattered aspen clones were observed, but not sampled. No other conifer species were recorded. Fifty-four percent of the lodgepole pine was infected with mistletoe, 19 percent was heavily infected, and the average mistletoe rating was 1.45.

The mountain pine beetle killed about 5 trees per acre in the Split Creek tract, 15 trees per acre in the Black Mountain tract, and 4 trees per acre in the Hatchery Butte tract (Tables 4, 5, and 6, Appendix). Almost all of the beetle-killed trees in these survey tracts were infected to some degree by mistletoe: Split Creek 97 percent, Black Mountain 98 percent, and Hatchery Butte 92 percent. The cumulative percentage of beetle-killed trees with heavy mistletoe infection exceeded the percentage estimated for the original living stands in each area: Split Creek, 43 versus 42 percent; Black Mountain, 64 versus 46 percent; and Hatchery Butte, 38 versus 19 percent. Also, the average mistletoe rating for dead trees was greater than the original stands in all cases: Split Creek, 3.31 versus 2.95; Black Mountain, 3.68 versus 3.07; and Hatchery Butte, 3.16 versus 1.45.

A separation of mountain pine beetle-killed trees by diameter classes revealed that there was no apparent preference for vigorous versus nonvigorous (heavily infected with mistletoe) trees (Tables 4, 5, and 6).

CONCLUSIONS

Data collected in the three survey tracts show that the mountain pine beetle killed many diseased and weakened lodgepole pine. Even though the data have not been analyzed statistically, there is some indication that the nonvigorous trees in the three stands were preferred. It is doubtful that the preference for nonvigorous trees was the result of a localizes situation, since there were considerable differences between the survey tracts. However, more intensive studies are needed to confirm the assumption that nonvigorous trees are selected.

In single-storied stands, the mountain pine beetle may be serving a beneficial role by killing mistletoe infected trees. By thinning stands and reducing the level of mistletoe infection, the growth rate of the remaining trees would be increased. Records show that three mountain pine beetle epidemics have occurred in portions of the Intermountain Region over the past 80 years, which adds weight to the assumption that stands quickly recover after an outbreak. In two-storied stands, the thinning process during an outbreak may create optimum conditions for mistletoe spread and could increase damage. Again, further study is needed to assess the relationships between the mountain pine beetle and mistletoe.

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APPENDIX

Figure 1. The mountain pine beetle killed this lodgepole pine that was heavily infected with dwarf mistletoe, Arceuthobium americanum, Targhee National Forest, 1973.

Table 1. Original lodgepole pine stand structure by diameter and dwarf mistletoe rating class in the Split Creek survey tract, Targhee National Forest, before the mountain pine beetle outbreak.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
5	5.25	5.25	--	5.25	5.25	--	--	21.00	6
6	7.28	3.64	3.64	--	3.64	3.64	14.56	36.40	11
7	5.36	--	10.72	10.72	10.72	5.36	10.72	53.60	16
8	6.12	2.04	18.36	2.04	8.16	4.08	4.08	44.88	13
9	8.05	11.27	11.27	8.05	8.05	1.61	3.22	51.52	15
10	6.06	3.96	9.24	6.06	7.92	5.28	2.64	41.16	12
11	4.28	2.14	3.21	7.49	7.49	3.21	5.35	33.17	10
12	5.34	1.78	1.78	4.45	5.34	1.78	0.89	21.36	6
13	0.75	0.75	3.75	1.50	3.00	--	2.25	12.00	4
14	1.36	0.68	0.68	0.68	2.04	2.04	2.04	9.52	3
15	0.57	--	0.57	--	0.57	0.57	0.57	2.85	<1
16	0.50	--	1.00	0.50	--	1.00	1.00	4.00	<1
17	0.46	--	--	--	--	--	--	0.46	<1
18	--	--	--	--	0.39	1.17	0.39	1.95	<1
19	--	--	--	--	--	--	--	--	--
20	--	--	--	--	--	--	--	--	--
21	--	--	--	--	0.30	--	--	0.30	<1
Total	51.38	31.51	64.22	46.74	62.87	29.74	47.71	334.17	100
Percent	15	10	19	14	19	9	14	100	

Table 2. Original lodgepole pine stand strucutre by diameter and dwarf mistletoe rating class in the Black Mountain survey tract, Targhee National Forest, before the mountain pine beetle outbreak.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
5	42.00	42.00	--	--	--	--	10.50	94.50	30
6	--	--	21.85	7.29	--	21.85	21.85	72.84	23
7	5.36	--	--	--	--	--	16.08	21.44	7
8	12.21	4.07	8.14	--	--	--	12.21	36.63	12
9	--	3.21	3.21	6.42	6.42	9.63	9.63	38.52	12
10	2.64	--	--	--	10.56	13.20	7.92	34.32	11
11	--	--	2.14	2.14	2.14	--	--	6.42	2
12	1.79	--	--	1.79	--	1.79	--	5.37	2
13	--	--	1.50	--	--	--	--	1.50	<1
14	--	--	--	--	1.36	--	--	1.36	<1
Total	64.00	49.28	36.84	17.64	20.48	46.47	78.19	312.90	100
Percent	20	16	12	6	6	15	25	100	

Table 3. Original lodgepole pine stand structure by diameter and dwarf mistletoe rating class in the Hatchery Butte survey tract, Targhee National Forest, before the mountain pine beetle outbreak.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
5	10.50	--	--	--	--	--	--	10.50	5
6	14.58	7.29	7.29	--	--	--	--	29.16	14
7	21.44	10.72	--	--	--	10.72	5.36	48.24	24
8	8.14	4.07	4.07	--	--	4.07	--	20.35	10
9	6.42	6.42	3.21	--	--	---	--	16.05	8
10	23.76	10.56	--	2.64	5.28	2.64	2.64	47.52	23
11	4.28	4.28	4.28	--	--	2.14	--	14.98	7
12	3.58	--	--	--	--	--	--	3.58	2
13	--	--	1.50	--	--	--	--	1.50	<1
14	--	1.36	2.72	--	--	--	1.36	5.44	3
15	--	--	--	--	1.14	--	--	1.14	<1
16	1.00	--	--	1.00	1.00	--	--	3.00	1
17	--	--	--	--	--	--	--	--	---
18	--	--	--	--	--	--	--	---	--
19	--	--	--	0.79	--	0.79	--	1.58	<1
20	--	--	--	0.64	--	--	--	0.64	<1
24	--	--	--	--	0.45	--	--	0.45	<1
25	--	--	0.37	--	--	--	--	0.37	<1
Total	93.70	44.70	23.44	5.07	7.87	20.36	9.36	204.50	100
Percent	46	22	11	2	4	10	5	100	

Table 4. Mountain pine beetle-caused mortality of lodgepole pine by diameter and dwarf mistletoe rating class in Split Creek, Targhee National Forest, 1973.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
10	--	0.17	0.17	--	--	--	--	0.34	7
11	--	0.17	0.34	0.17	--	0.17	0.34	1.19	22
12	--	--	0.17	--	--	0.17	0.17	0.51	9
13	0.17	--	0.34	--	--	--	--	0.51	9
14	--	0.34	--	--	0.51	0.17	0.17	1.19	22
15	--	--	0.17	0.17	--	--	0.17	0.51	9
16	--	--	--	0.17	0.17	0.17	--	0.51	9
17	--	--	--	0.17	--	--	--	0.17	3
18	--	--	--	--	--	--	--	--	--
19	--	0.17	--	0.17	--	--	--	0.34	7
20	--	--	--	--	--	--	--	--	--
21	--	--	--	--	--	--	0.17	0.17	3
Total	0.17	0.85	1.19	0.85	0.68	0.68	1.02	5.44	100
Percent	3	16	22	16	12	12	19	100	

Table 5. Mountain pine beetle-caused mortality of lodgepole pine by diameter and dwarf mistletoe rating class in the Black Mountain survey tract, Targhee National Forest, 1973.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
8	--	--	0.33	0.33	---	0.99	--	1.65	11
9	--	0.33	0.33	--	1.32	0.66	0.66	3.30	23
10	0.33	--	0.33	0.33	0.33	0.99	0.33	2.64	19
11	--	--	0.33	0.66	0.66	0.33	0.33	2.31	16
12	--	0.66	--	0.33	0.99	0.33	--	2.31	16
13	--	--	--	0.33	--	--	--	0.33	2
14	--	0.33	--	--	0.99	0.33	--	1.65	11
15	--	0.33	--	--	--	--	--	0.33	2
Total	0.33	1.65	1.32	1.98	4.29	3.63	1.32	14.52	100
Percent	2	11	9	14	30	25	9	100	

Table 6. Mountain pine beetle-caused mortality of lodgepole pine by diameter and dwarf mistletoe rating class in the Hatchery Butte survey tract, Targhee National Forest, 1973.

	Number of Trees/Acre by Dwarf Mistletoe Rating								
DBH	0	1	2	3	4	5	6	Total	Percent
11	--	--	--	--	0.33	--	--	0.33	8
12	--	--	--	--	--	--	--	--	--
13	--	--	0.33	--	--	--	--	0.33	8
14	0.33	--	0.66	0.33	--	--	--	1.32	30
15	--	--	--	0.33	--	--	--	0.33	8
16	--	--	--	--	0.33	0.33	--	0.66	14
17	--	--	--	--	--	0.33	--	0.33	8
18	--	--	--	--	--	--	--	--	--
19	--	--	--	0.33	--	--	--	0.33	8
21	--	--	--	--	--	--	0.33	0.33	8
24	--	--	0.33	--	--	--	--	0.33	8
Total	0.33	--	1.32	0.99	0.66	0.66	0.33	4.29	100
Percent	8	--	31	23	15	15	8	100	